A STUDY TO ESTABLISH DEGRADATION PROFILES FOR SIX PESTICIDES (TRIFORINE, ENDOSULFAN, CHLOROTHALONIL, SULFOTEP, DODEMORPH ACETATE, AND DAMINOZIDE) USED ON ORNAMENTAL FOLIAGE IN SAN DIEGO COUNTY CALIFORNIA DURING FALL 1986

by

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SUMMARY

Three major growers of ornamental plants were selected as sites for studies to establish degradation profiles for six pesticides: triforine, endosulfan, chlorothalonil, sulfotep, dodemorph acetate, and daminozide. There were limited data available concerning dislodgeable foliar residue levels in greenhouses for these pesticides. At the expiration of the reentry intervals, average dislodgeable residue values for each pesticide were as follows: chlorothalonil, 0.55 micrograms per square centimeter (ug/cm^2); triforine, <0.01 ug/cm^2; sulfotep, 0.44 ug/cm^2; dodemorph acetate, 1.89 ug/cm^2; and daminozide, 3.06 ug/cm^2. Total endosulfan residue values ranged from 1.08 to 69.05 ug/cm^2, depending on the sampling site within the greenhouse. Although none of the pesticides investigated during this study have safe levels established, it appears that the residue levels are sufficiently low to protect against acute effects. Currently, there is not sufficient information to calculate levels that protect against chronic effects.

INTRODUCTION

In June 1986, several greenhouse ornamental plant growers in San Diego County indicated to the California Department of Food and Agriculture (CDFA) that the established reentry intervals on critical pesticides interfered with essential cultural practices. A reentry interval is the time period which must elapse between the application of a pesticide and the entry of unprotected workers into the treated area. Many of the reentry intervals in question had been determined with minimal residue degradation research data available. Ornamental growers are confronted with particular difficulties in regards to reentry intervals. Unlike many other agricultural commodities, the value of horticultural products is very dependant on physical appearance. Damage to the plant, especially flowering portions, can reduce a plant's marketability severely, whereas fruits and vegetables with slight appearance defects can still be sold in the fresh market or at least to processing plants to be canned, juiced or otherwise used. Also in contrast with most agricultural commodities, ornamentals often have a short "window of harvest", since a slight change in appearance (blooming of roses, for example) can severely devalue the product. All these factors have induced growers in San Diego County (where many of California's greenhouses are locationed) to seek a variance in some of the reentry intervals. The Worker Health and Safety Branch was directed to conduct degradation studies on the pesticides in question. The resulting information will be used to assess the existing reentry intervals. The following pesticides were targeted for study: chlorothalonil, endosulfan, dodemorph acetate, triforine, sulfotep, daminozide, azinphos-methyl, and methomyl. All but azinphos-methyl and methomyl were examined; both of these chemicals were subsequently dropped from consideration for reentry modification.

METHODS AND MATERIALS

With assistance from the San Diego County Agricultural Commissioner's office, cooperation was obtained from three greenhouse growers who would be applying the pesticides of interest. Grower A was a major producer of pointsettias. Grower B produced a wide variety of chrysanthemums while Grower C had a large area devoted to roses. The following is a breakdown of the crop/pesticide combinations studied at each greenhouse:

Grower A

Grower A was a major producer of pointsettias in San Diego County but also had some minor plant stocks. The pesticide products used on the pointsettias were: DACONIL 2787 (chlorothalonil, EPA #677-315ZA), and PLANTFUME 103 (sulfotep, EPA #8241-4AA). Hydrangea plant stock was treated with FUNGINEX (triforine, EPA #239-2455AA). Plantfume 103 was also applied to geraniums.

The Daconil 2787 (chlorothalonil), is 75 percent active ingredient fungicide in a flowable formulation. This product, though of a low dermal/oral toxicity, is a Category I pesticide, because it is an eye irritant. It is also a suspect teratagen. The material was applied to pointsettias using two different application systems.

A multi-nozzle, short-neck, hand sprayer (FOGG-IT brand) was used on three of the study sites. This device creates a fan-shaped spray pattern. It was connected by high-pressure hose to a 250 gallon tank powered by a BEAN pump system. The dilution rate of 0.62 pounds of active ingredient per 100 gallons of water yielded a calculated value of 1.88 pounds of active ingredient per acre using 300 gallons of water as the average application rate per acre. The calculation of amount per acre is estimated since greenhouse facilities normally use bench area for their application calculations. The workers, in full protective equipment, would walk backwards through the rows, spraying onto the plants they had just walked past. This reduced the applicator's potential for exposure to dislodgeable residue as well as mist from the application. The material was applied over the top of the plants, depositing primarily on the exposed plant surface, the growing bench, and the walkway.

The second application method made use of a thermal fogging unit (DRAMM International PULSFOG). This application device applies the material in a fog generated by a high temperature aerosol generator, essentially a small jet engine. The fogger mixes the pesticide (in this case chlorothalonil) with a volatile carrier (VK-II containing methylene chloride), injects the mixture into an operational combustion chamber and discharges the finely atomized mixture out of its exhaust. According to the grower, they need only 40 percent of the pesticide used in a standard spray application to achieve the same efficacy. Therefore their application rate should correspond to 0.75 pounds of active ingredient per acre. The applicators, in full protective gear (including hearing protection), placed the fogger outside the greenhouse and aimed the exhaust nozzle into the greenhouse. They ran the unit for approximately five minutes, then shut it down and moved to the next entrance.

Funginex (triforine), registered by Chevron Chemical Co., contains 1.6 pounds triforine per gallon in an emulsifiable concentration formulation. Though of a low dermal/oral toxicity, it is a Category I fungicide due to its ability to cause eye irration. This product was applied to hydrangea using the same wet spray methodology as chlorothalonil. However, the plants were much smaller than poinsettias and were placed directly on the ground, not on a growing bench. These early stage hydrangea pose little hazard for dislodgeable residue contact. The dilution rate of 0.88 pounds of formulation per 100 gallons of water corrosponded to 0.175 pounds active ingredient per acre.

Plantfume 103 (sulfotep), registered by Plant Products Corp., contains 15 percent active ingredient. It is an organophosphate pesticide formulated in a smoke generating canister, which is activated by insertion of a burning brand into holes punched in the top of the can. The same holes act as the exit points for the pesticide smoke. The cans are suspended 1.5 meters from the floor by rigid wires attached to overhead support beams. These cans were designed to generate 10,000 cubic feet of smoke sufficient for treatment of an area 120,000 cubic feet in size. This pesticide was used on both pointsettias and geraniums to kill insect pests.

Grower A's facility was composed largely of rigid, permanent greenhouse structures. A greenhouse is a joined collection of individually identified "houses". Each house averages approximately 6 meters wide by 65 meters long. However, the length dimension varies considerably depending on the greenhouse. On average there were 18 houses connected together lengthwise to form one range. There are no walls between the houses, only one around the perimeter of the range. The walls and ceiling were made from rigid, translucent plastic attached to a wooden superstructure. Each house contains from six to eight growing tables, or "benches". Benches can be simple irrigated flat tables, waist high (as used for new growth stock and potted plants) or deep (2.5 foot), soil containing planter-boxes (for vegetative stock). Sulfotep was applied to irrigation tables while chlorothalonil was applied to planter-box benches. Triforine was applied to individually potted hydrangea which sat on a bed of crushed rock on the ground. These hydrangea were housed in a semi-rigid, temporary structure of flexible Saran[R] plastic sheeting, "fish-net" side screens, and rigid, minimum load-bearing support members.

Since each house had structural differences (number of benches, type of bench, length of house etc.) a flexible sampling protocol was developed. In general, the following scheme was used:

The treated area was identified and marked to ensure reproducibility. An imaginary diagonal was projected from one corner of the treated rectangular area to the opposing corner. The two ends of the line and its center were considered the sampling areas. In each section of the sampling area, leaf disks were collected from a bench (20 disks for pointsettias and geraniums, 16 disks for hydrangea because of leaf thickness). Usually, half of the samples were taken from one side of the bench and the remaining samples were taken from the other side. Duplicate samples were taken simultaneously. After collection in one section, sampling would proceed to the next area along the diagonal, then finally to the opposite end, for a total of 60 leaf disks per sample (48 for hydrangea) from each treated area. Sampling was done at selected time intervals that varied for the type of material and the plant being sampled. In general pre-application samples were taken immediately before the application and post-application samples were taken twice before the expiration the the 24 hour reentry, at the 24 hour mark and once after the expiration of the reentry interval. Specific sampling times are given in the result tables. Leaf samples were taken using a Birkestrand 2.54 centimeter (cm) diameter leaf punch. Sample disks were accumulated in four-ounce glass jars. After collection of the samples, the glass jars were sealed with aluminum foil, screw-capped and stored on wet ice. The leaf punches were cleaned between sampling sites using 70 percent isopropyl alcohol.

Since sulfotep is applied as a fumigating smoke, potential inhalation exposure was also measured. The air sampling train consisted of a plastic filter cassette (SKC 225-2) loaded with a glass fiber filter (SKC 225-7); this was connected by a short length of TYGON tubing (formulation B44-4X) to a Chromosorb 102 sorbent tube (SKC 226-49-21-102). This sample train was connected by a second piece of TYGON to a MSA FIXT-FLO MODEL 1 personal air sampling pump. Pumps were positioned inside the greenhouse and on each of the two sample collection personnel. Air sampling rates were initially set at 0.75 liters per minute (L/min) using a KURZ 540S Mass Flow Calibration Meter. As degradation/dissipation of the material occurred, the sampling flow rate was increased, 1.5 L/min for the stationary sampler and 2.0 L/min for the pumps worn by the the sampling personnel.

Samples were extracted and analyzed at CDFA's Mobile Chemistry Laboratory within eight hours of collection.

Grower B

Grower B produced a wide assortment of ornamental plants, including several different varieties of roses. MILBAN (dodemorph acetate, EPA #372-51AA), registered by Mallinckrodt Inc., was used as a fungicide on roses. It contains three pounds of active ingredient per gallon in an emulsifiable concentrate formulation. Though of moderate oral toxicity it is severely corrosive to the eye, hence its classified as a Category I pesticide.

The material was applied to roses using a hand-held spray wand (unknown manufacture). It was diluted to two pounds of formulation per 100 gallons of water. This is equivalent to 0.75 pounds of active ingredient per 100 gallons or 2.25 pounds of active ingredient per acre in 300 gal/acre. The applicators used good work practices during application to ensure minimum exposure.

Grower B's facility was composed largely of rigid, semi-permanent greenhouse structures. The walls and ceilings were made from heavy gauge plastic sheeting supported by a rigid wooden superstructure. The basic plan of the greenhouses, that of multiple smaller houses connected to form one large range, was essentially the same as that of Grower A. Grower B's benches were shallower than Grower A's. Grower B had soil-containing planter-boxes set into the ground with a four to six inch tall wooden border surrounding the growing soil. A multi-level, horizontal lattice-work of wires ran over the top of the soil, which acted as support for the long stems of the growing rose stock. Rose stems reach heights of four to five feet.

The treated area was sampled in a similar manner as Grower A's poinsettias. However, for the first application a 1.25 cm Birkestrand leaf punch was used, since the rose leaves did not at first appear large enough to use the 2.54 cm punch. Since it results in a reduced total sampling area, the number of leaf punches was increased to 120. On the second application set it was determined that the 2.54 cm punch could be used and the number of punches was reduced back to 60. All other sampling and storage conditions were the same as described for Grower A.

Grower C

Grower C had a large amount of greenhouse area devoted to potted plant production. In particular, chrysanthemums were a major production crop. The materials used on these mums were: B-NINE SP (daminozide, EPA #400-110AA) and THIODAN 50WP (endosulfan, EPA #279-1380AA).

The B-Nine SP (daminozide), registered by Uniroyal Chemical Co., is 85 percent active ingredient in a soluble powder formulation. It has a low dermal/oral toxicity but is a suspect carcinogen. B-Nine, a Category III pesticide, is used as a growth regulator.

This product was applied using a hand-held wand (unknown manufacture) connected by high-pressure hose to a pump serving a 250 gallon tank. The wand was roughly one meter long with five nozzle heads evenly spaced. The nozzles generated a cone-shaped spray swath and was held one-half meter above the plants during treatment. Only the middle three nozzles were activated; the two end nozzles had been closed off. The workers wore adequate protective equipment, including face-shield and organic vapor respirator. The bench layout was different than Growers' A or B, so the applicator would have to walk forward, beside the spray zone. However, the nozzles were adequately distant from the worker to prevent gross contamination. The material was applied directly over the plants with little visible off-site drift. The dilution rate was reported by the grower as 2.40 pounds of formulation per 100 gallons. Their water delivery rate was estimated at 90 gallons per acre. Thus the estimated application rate of 2.16 pounds of formulation per acre yields 1.84 pounds of active ingredent per acre.

Thiodan 50WP (endosulfan), registered by FMC Corp., is 50 percent active ingredient in a wettable powder formulation. It is a Category I material. It was applied in a similar manner to daminozide. The grower reported the delivery rate to be 100 gallons of water to two-thirds acre, calculated to be 150 gallons per acre. The application rate was calculated to be 0.75 pounds of active ingredient per acre.

Grower C's facility was also a rigid, semi-permanent greenhouse. The walls and ceiling were heavy gauge plastic supported by a rigid wooden superstructure, similar to Grower B. It also used a fused, multi-house design, comparable to Grower B's layout. However, the benches were of a totally different construction. The plants were individually potted and placed on a one meter high wire topped table. The middle of the benches were connected by a lateral, creating a U-shape, thus preventing a walk-through from one end of the bench to the other. One U-shaped area constituted a complete sampling site. The first three daminozide sample sites and the first two endosulfan sites were sampled using a 1.25 cm diameter Birkestrand leaf punch, taking a total of 120 punches per bottle, with replicate samples obtained simultaneously. Approximately 50 punches done ere taken from each arm of the "U" and 20 punches were taken from the lateral. Subsequent sampling was done with the standard 2.54 cm punch, taking 15 punches from each arm and 10 at the base for a total of 40 leaf discs per sample. The number of leaf punches was reduced not only because of the larger size disks but also to prevent serious physical and economic damage to the plant. Leaf disks were taken with greater density per plant than at the other growers since the area of sampling was smaller. All other sampling and storage conditions were identical to Growers A and B.

RESULTS AND DISCUSSION

Three foliar chlorothalonil applications, all made to poinsettias, were monitored (Table 1). The application at site 1 was made by management personnel not normally involved in this type of application, which may explain why the dislodgeable residue levels at this site are approximately half of those sampled from the other two locations. For this reason, the values from site 1 were not included in mean calculations. Average chlorothalonil values from sites 2 and 3 ranged from a high of 0.74 ug/cm^2 four hours post-application to a low of 0.42 ug/cm^2 37 hours after the application, with 0.55 ug/cm^2 present at the end of the 24 hour reentry interval. A similar study, conducted in Monterey greenhouses, monitored applications of chlorothalonil to stock carnations. Average dislodgeable residue values at the end of the 24-hour reentry interval ranged from 2.65 to 5.11 ug/cm^2 (Edmiston and Rech, 1987) considerably higher than the levels found on the poinsettia foliage. Chlorothalonil was applied at a higher rate to the carnations than to the poinsettias (2.40 versus 1.88 pounds active ingredient/acre). Another important difference in the applications were the types of spray wands used. The poinsettias were treated with a multi-nozzle, short-neck hand sprayer which created a fan-shaped spray pattern. The carnations were treated using a spray wand with four large nozzles located at equal distances along a three foot long pole. Each nozzle had 10 to 20 openings. This type of wand was designed to spray the entire width of a bench at one time which provides more complete coverage than the short-neck spray wand.

Two chlorothalonil applications using a thermal fogging unit were also monitored. Thermal fogging is the preferred method for fungicide applications. Treatment can be made by thermal foggers in less time using less diluent and 40 percent less pesticide than with conventional spraying. The fogger results in residue deposits not only on the foliage but on all available surfaces within the greenhouse, effectively reducing any reservoir of re-infestation. Results from the first site were similar to levels measured following foliar application, with an average value of 0.50 ug/cm^2 at the end of the reentry interval. The second site had lower dislodgeable levels than the first site, with 0.35 ug/cm^2 present at the end of 24 hours (Table 2). Both sites were treated at the same application rate, by the same personnel, and were the same plant type (stock poinsettias).

Triforine dislodgeable residue levels on hydrangea plants were very low, with the highest level (0.086 ug/cm^2) found in a sample collected three hours following the 0.175 pounds active ingredient/acre application. By the expiration of the 24-hour reentry interval, all samples were below the 0.01 ug/cm^2 minimum detectable level (Table 3). An earlier study found average triforine residue levels on roses in Monterey County to be 0.25 ug/cm^2 24-hours following a 0.63 pound active ingredient per acre application, and 0.66 ug/cm^2 23 hours after a 0.45 pound active ingredient per acre application (Edmiston and Rech, 1987). The roses were grown in greenhouses constructed of rigid materials, whereas the hydrangeas were grown in houses constructed primarily of screening. The increased ventilation as well as the lower application rate probably were factors in the reduced dislodgeable residue level on the hydrangea foliage.

Sulfotep, when applied through a smoke-generating canister, was present on poinsettia and geranium foliage at very low levels (Table 4A). Sampling began 14 to 15 hours following application, as it is standard practice to ignite the smoke-generating canisters in the evening, and ventilate the greenhouse for two hours the following morning before allowing workers to enter. The average dislodgeable residue level 15 hours after the application was 0.04 ug/cm^2. Geranium dislodgeable levels were slightly higher than those obtained from poinsettias, the highest value measured during the study was 0.05 ug/cm^2 from geraniums samples collected 15 hours after application. The higher sulfotep residue values from geraniums may be due to the difference in the epidermal layer of the two plant types. The geranium epidermal layer is covered with hairs, which may initally trap more of the pesticide smoke than the smooth poinsettia foliage. Because of the concern for worker's potential inhalation exposure, air sampling was done simultaneously during foliage sampling. The American Conference of

Governmental Industrial Hygienists Threshold Limit Value - Time Weighted Average (TLV-TWA) for sulfotep is 200 ug/m^3. This is the TWA concentration for a normal eight-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed without adverse effect. The highest value sampled after the ventilation period ws 14.09 ug/m^3 (Table 4B). Assuming a worker spent eight hours working within an atmosphere at this concentration, his eight-hour TWA would be 14.09 ug/m^3, well below the TLV-TWA.

The highest average dodemorph acetate residue level, 1.89 ug/cm^2, was found on rose foliage taken two hours after the application. Residues degraded to an average of 0.62 ug/cm^2 by the end of the 24-hour reentry interval (Table 5). Dodemorph acetate levels remained relatively stable following an initial fast degradation; the average residue level present at 41-hours post-application was 0.66 ug/cm^2.

Daminozide levels remained high throughout the 31-hour sampling period. The average value was 3.06 (4.21 to 2.07) ug/cm^2 at the expiration of the 24-hour reentry interval, degrading to 1.65 ug/cm^2 by the final sampling (Table 6). Daminozide applications were made on a weekly schedule to various sections of the greenhouse, with treated and untreated plants in close proximity. This may account in part for the fact that all pre-application samples had detectable amounts of the material present.

Technical endosulfan is a mixture of two stereoisomers. Endosulfan I (α -isomer) constitutes about 70 percent of the material, with about 30 percent made up of endosulfan II (β -isomer), small amounts of the hydrolysis product, endosulfan diol, and the oxidation product, endosulfan sulfate (Hayes, 1982; Harrison et al., 1967). Most studies have shown the sulfate to be the major environmental residue of endosulfan, as it is less volatile than either endosulfan I or II (Harrison et al., 1967). The rate of endosulfan sulfate formation on the growing plant increases with increasing ambient temperatures with very little formed at 60 to 65^o F (Cassil and Drummond, 1965, Harrison et al., 1967). The average temperature within the greenhouses treated with endosulfan was 80^{o}F, which is conducive to sulfate formation. Two sampling sites were selected for each endosulfan application, one along the main walkway of the greenhouses and the other within one of the U-shaped benches in the middle of the greenhouse. Results from the sampling done along the main walkway were higher following both applications, especially following application #1 (Table 7) when the average dislodgeable residue value for all endosulfan isomers combined was 69.05 ug/cm^2, as compared to the 20.08 ug/cm^2 sample from the U-shaped benches. Results from the second application followed a similar pattern, with an average dislodgeable residue value of 2.06 ug/cm^2 sampled from the walkway, and 1.08 ug/cm^2 from the U-shaped bench site. It is possible that foliage along the main walkway may be inadverently sprayed more often, such as when the applicator is moving to another spray site.

CONCLUSIONS

For a number of pesticides, safe levels of foliar pesticide residues have been calculated or estimated from animal studies. These levels allow unprotected workers to enter treated fields without risking acute toxicity. None of the pesticides investigated during this study have estimated safe levels. However, Worker Health and Safety data suggests that less than three percent of the total illnesses attributed to pesticides in California have occurred to greenhouse workers since 1979. This would indicate that current reentry intervals are adequate to protect against acute effects. Currently, sufficient information is not available to calculate levels that protect against chronic effects (some of the pesticides studied are suspected of causing various chronic effects). When such information becomes available, the reentry intervals of the seven pesticides investigated during this study may be modified.

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Table 1

Chlorothalonil Foliar Spray Application Method - Poinsettias
(ug/cm^2)

	Site 1*		Site 2		Site 3		Average
	A	B	A	B	A	B	
Pre-application	ND	ND	ND	ND	0.16	-	
3 hours post	-	-	0.60	0.47	-	-	0.54
4 hours post	-	-	-	-	0.76	0.71	0.74
5 hours post	0.31	0.29	-	-	-	-	
6 hours post	-	-	-	-	0.65	0.74	0.70
9 hours post	0.31	0.30	-	-	-	-	
12 hours post	-	-	0.63	0.61	-	-	0.62
15 hours post	-	-	-	-	0.62	0.66	0.64
16 hours post	0.26	0.27	-	-	-	-	
19 hours post	-	-	-	-	0.62	0.51	0.56
24 hours post	0.21	0.24	0.48	0.45	0.60	0.67	0.55
36 hours post	-	-	-	-	0.66	0.54	0.60
37 hours post	0.23	0.18	0.43	0.41	-	-	0.42

Application rate = 1.88 pounds active ingredient/acre
*Application made by management personnel. Values from this application not used to calculate average values

Table 2

Comparison of Dislodgeable Residue Levels
Foliar Versus Fogger Application
(ug/cm^2)

SITE 1

	Foliar			Fogger		
	A	B	Average	A	B	Average
Pre-application	ND	ND	ND	ND	ND	ND
5 hours post	0.31	0.30	0.30	0.71	0.73	0.72
9 hours post	0.31	0.30	0.30	0.69	0.63	0.66
16 hours post	0.26	0.27	0.26	0.77	0.72	0.74
24 hours post	0.21	0.24	0.22	0.51	0.50	0.50
37 hours post	0.23	0.18	0.20	0.60	0.56	0.58

SITE 2

	Foliar			Fogger		
	A	B	Average	A	B	Average
Pre-application	ND	ND	ND	ND	ND	ND
3 hours post	0.60	0.47	0.54	0.26	0.27	0.26
12 hours post	0.63	0.61	0.62	0.37	0.38	0.38
24 hours post	0.48	0.45	0.46	0.35	0.35	0.35
37 hours post	0.43	0.41	0.42	0.32	0.33	0.32

Foliar spray application rate = 1.88 pounds of active ingredient/acre
Fogger application rate ≅ 0.75 pound of active ingredient/acre
ND = none detected
Minimum detectable level = 0.08 ug/cm^2

Table 3

Triforine Dislodgeable Residue Levels - Hydrangea (ug/cm^2)

	Site 1				Site 2				Average Value
	A	B	C	D	A	B	C	D	
Pre-application	ND	ND	ND	ND	ND	ND	ND	ND	ND
3 hours post	-	-	-	-	0.05	0.09	0.07	0.07	0.07
4 hours post	0.05	0.05	0.04	0.04	-	-	-	-	0.04
6 hours post	-	-	-	-	ND	ND	ND	ND	ND
8 hours post	ND	ND	ND	ND	-	-	-	-	ND
24 hours post	ND	ND	ND	ND	ND	ND	ND	ND	ND

Applicate rate = 0.52 pound active ingredient/acre
ND = none detected
Minimum detectable level = 0.01 ug/cm^2

Table 4A

Sulfotep Dislodgeable Residue Levels
(ug/cm^2)

	Poinsettias Site 1 A	Poinsettias Site 1 B	Poinsettias Site 2 A	Poinsettias Site 2 B	Geraniums Site 3 A	Geraniums Site 3 B	Average Value
Pre-application	ND	ND	ND	ND	ND	ND	ND
14 hours post	0.02	0.02	-	-	-	-	0.02
15 hours post	-	-	0.04	0.04	0.05	0.05	0.04
24 hours post	0.01	0.01	0.02	0.02	0.03	0.03	0.02
36 hours post	ND	ND	-	-	-	-	0.01
38 hours post	-	-	0.01	0.01	0.02	0.03	0.02

ND = none detected
Minimum detectable level = 0.005 ug/cm^2

Site 2 and 3 were sampled following the same application

Table 4B

Sulfotep Air Levels
(ug/m^3)

	Investigator 1	Investigator 2	Area Sample
Application 1:			
3 hours post	-	-	81.73
14 hours post	6.94	10.05	7.42
24 hours post	-	-	8.83
Application 2:			
15 hours post	8.64	14.09	8.14
24 hours post	13.44	10.92	8.83

Reported values are the combined residue levels from the glass fiber filter and sorbent tube.

Table 5

Dodemorph Acetate Dislodgeable Residue Levels - Roses
(ug/cm^2)

Sampling Time	Site 1				Site 2				Average Value
	A	B	C	D	A	B	C	D	
Pre-application	0.34	0.24	0.21	0.23	ND	-	ND	-	0.21
2 hours post	2.37	2.58	1.93	2.40	-	-	0.99	1.07	1.89
14 hours post	-	-	-	-	0.83	0.71	0.75	0.91	0.80
19 hours post	0.84	1.30	0.92	0.67	-	-	-	-	0.93
24 hours post	0.86	0.81	0.45	0.65	0.91	0.89	0.19	0.17	0.62
39 hours post	-	-	-	-	0.83	0.60	0.21	0.23	0.47
41 hours post	0.85	0.86	0.50	0.42	-	-	-	-	0.66

Application rate = 2.25 pounds active ingredient/acre
ND = none detected
Minimum detectable level = 0.12 ug/cm^2

Table 6

Daminozide Dislodgeable Residue Levels - Chrysanthemums
(ug/cm^2)

Sampling Time	Site 1						Site 2				Average Value
	A	B	C	D	E	F	A	B	C	D	
Pre-application	-	1.26	-	1.01	-	0.78	0.58	0.64	1.32	0.82	0.92
8 hours post	4.45	4.88	4.41	4.10	3.73	3.64	1.86	1.43	2.12	1.42	3.20
24 hours post	4.08	4.21	3.22	3.64	2.80	2.82	2.42	2.53	2.07	2.86	3.06
31 hours post	1.83	1.63	1.64	2.09	2.12	1.84	1.64	1.43	1.35	0.97	1.65

Application rate = 1.84 pounds active ingredient/acre

Table 7

Endosulfan Dislodgeable Residue - Chrysanthemums
(ug/cm^2)

Application #1:

	A I/II/S	B I/II/S	Average I/II/S	C I/II/S	D I/II/S	Average I/II/S
Pre-application	0.10/0.26/ND	0.31/0.30/ND	0.20/0.28/ND	0.02/0.16/ND	0.01/0.09/ND	0.02/0.12/ND
3 hours post	56.50/27.30/0.85	45.90/21.70/0.51	51.20/24.50/0.68	17.90/9.69/0.19	17.90/10.30/0.23	17.90/10.00/0.21
9 hours post	43.90/24.60/0.79	36.80/21.00/0.50	40.35/22.80/0.64	13.20/8.75/0.17	15.60/10.00/0.15	14.40/9.38/0.16
24 hours post	43.40/25.60/0.49	42.80/25.30/0.50	43.10/25.45/0.50	12.90/9.44/0.20	9.54/7.87/0.19	11.22/8.66/0.20
32 hours post	41.20/22.50/0.50	37.90/20.60/0.51	39.55/21.55/0.50	11.10/9.12/0.17	12.20/9.97/0.18	11.65/9.54/0.18

Application #2:

	A I/II	B I/II	Average I/II	C I/II	D I/II	Average I/II
Pre-application	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND
15 hours post	1.56/0.99	1.40/0.80	1.48/0.90	0.84/0.49	0.91/0.53	0.88/0.51
24 hours post	1.13/0.88	1.20/0.93	1.16/0.90	0.58/0.43	0.67/0.50	0.62/0.46
39 hours post	0.79/0.69	0.83/0.76	0.81/0.72	0.45/0.37	0.31/0.54	0.38/0.45

Application rate = 0.75 pound active ingredient/acre
ND = none detected
Minimum detectable level for all forms = 0.01 ug/cm^2
I = Endosulfan I
II = Endosulfan II
S = Endosulfan sulfate (all samples from application #2 were ND for endosulfan sulfate)
Replicates A and B were samples from foliage along the main walkway
Replicates C and D were samples from foliage along U-shaped benches